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Description

The present invention relates to the securing of first members, such as lids, to second members, such as boxes, and more particularly to the use of a specific type of heater attached to the lid of a box for heating the lid and thermally activating a sealant disposed between the lid and the vertical on end walls of the box.

The present invention is described as applied to a specific prior art problem but it should be recognized that the teachings relating to attaching lids, sidewalls, bottoms, etc. to boxes or containers are universal in applicability and are described as applied to a particular problem as that problem led to the present invention.

The microwave segment of the electronic industry has grown very rapidly in recent years. The circuits themselves are typically located in small, hermetically sealed boxes: The boxes typically have one or more cavities full of circuitry and components, each of which has a lid. Lids are attached by means of welding, laser welding, soldering, etc.

Lid attachment and removal is a real cost and expense. No one method is preferred and all methods have drawbacks. The very high dollar value of these boxes leads to a need to re-enter boxes for rework. Likewise, as many or most of these boxes are for military/aerospace end use, inspection leads to the need to re-enter a box. Obviously, the need to machine off a lid to re-enter as is often the case now, is a huge drawback to lid welding. Likewise, laser welding is both a high capital cost and high labor cost process.

Soldered lids have their drawbacks. A major drawback has been the flux/contaminant issue. More critical has been the inability to heat the lid contact area uniformly and all at the same time. Soldering irons obviously cannot do the job so that most lids are soldered on in ovens. This method has its own drawbacks, including a relatively long high temperature "soak" of the box and its components. Despite this, the relative ease of re-entry makes soldered-on lids desirable. Boxes are typically placed on a hot plate for reopening.

There are a large number of lid shapes and dimensions. There are also many different solders used, hence a wide range of soldering temperatures. Boxes are typically aluminum, plated with tin or gold. Lids are made of aluminum, Kovar, etc., and are also plated.

In WO-A-80/02124 there is described a technique for jointing pipes and pipe fittings in which Joule heating is applied to effect fusion jointing by means of an internally incorporated temperature auto-regulating heater energised by an alternating current work coil temporarily fitted externally around the region of the joint. However, that technique does not at all deal with the problem of hermetically sealing covers on to boxes or enclosures containing valuable electronic components, especially when there is a need to be able subsequently to re-enter the box to gain access to the components it contains.

According to the present invention, there is provided an assembly comprising a first member, such as a cover, sealable to a second member, such as a box, by heat-activated sealant, and a temperature-regulated electrical heater positioned to provide Joule heating to activate the sealant and having an energising circuit adapted to be connected to a source of alternating current, characterised in that the temperature-regulated heater is an auto-regulating heater comprising a layer of a magnetic material that undergoes a substantial change in electrical impedance with change in temperature and is secured on one surface of said first member said energising circuit is adhered to said auto-regulating heater magnetic layer, and said auto-regulating heater further has an electrically-conductive layer provided either by said first member or by an additional electrically-conductive layer.

The invention further provides a method of sealing a cover to a box such that the cover and box can be subsequently unsealed, and wherein the sealing is achieved by means of a heat-activated sealant that is activated by a temperature-regulated electrical heater energised by a source of alternating current, comprising the steps of:

i) affixing to the outer surface of the cover a layer of a magnetic material that undergoes a substantial change in electrical impedance with change in temperature, said magnetic layer having contiguous with it an electrically-conductive layer provided either by the cover itself or an additional layer, the two layers constituting an auto-regulating electrical heater,

ii) applying a heat-activated sealant between the mating surfaces of the cover and box,

iii) adhering an energising electrical circuit to said magnetic layer,

iv) and passing alternating current through said energising circuit such as to raise the temperature of the auto-regulating heater to a level at which the sealant is activated but which cannot substantially exceed the temperature level at which the heater auto-regulates. The present invention may utilise temperature auto-regulating heaters of any one of the types disclosed in US-A-4,256,945 to Carter et al, and WO-A-85/00263.

The aforesaid US-A-4,256,945 discloses an auto-regulating heater comprising a layer of magnetic material coated on a conductive layer such as copper. A further or return conductor is disposed adjacent the magnetic layer and insulated therefrom except at an end of each where the two are connected together. The other ends of the return conductor and the magnetic material are connected across a constant current a.c. source, preferably though not necessarily a source in the range of 8MHz to 20 MHz.

In operation, below the Curie point of the magnetic metal, the current due to skin effect and the proximity effect of electrical systems, is essentially confined to the magnetic material, i.e. the material adjacent the return conductor. As the temperature of the device approaches the Curie temperature and the permeability of the magnetic material approaches unity, the current spreads into the copper and the resistance of the heater is reduced. Since current is constant, the Joule heating is greatly reduced, and subsequently the magnetic material falls below its Curie temperature and the cycle repeats. Thus the heater is auto-regulating.

Variations of some of the details of the basic design of the aforesaid heater are disclosed in the aforesaid WO-A-85/00263 and that design may also be applied herein although only the embodiments that follow below are described herein for purposes of brevity.

In accordance with an embodiment of the present invention a heater structure including at least the magnetic material as disclosed in said patent is preferably permanently bonded to the top surface of the lid. The return conductor or its equivalent as hereinafter explained may be secured to a layer of insulation having a tacky substance on its surface remote from the return conductor. Thus, the insulation may be "stuck" to the magnetic material and the heater energised. After the lid is secured, the insulation and return conductor may be removed leaving behind the heater structure. When re-entry is desired a return conductor and insulation array is simply reapplied to this heater structure on the lid, the heater activated and the lid removed.

It should be noted that the exposed edges of the main structure, i.e. the box, which are to receive the lid may conveniently have concave longitudinal grooves to hold solder or the like. Thus when the lid is applied and heated, the solder liquifies and lid attachment is completed. Two approaches to the solder may be employed. The solder may be placed in the groove and the box heated to melt the solder and bond it to the box before any components are placed in the box. This approach has the merit that excellent thermal conduction between the solder and the box during application of the lid is assured from the very beginning thereby reducing the heating time required to obviate a cold solder connection.

The second approach to the solder is that a solder preform, solder wire, or liquid solder is laid in the groove and melted upon heating. Heating takes longer but the merit to this approach is the elimination of the extra heating step.

The basic benefit to be realized by the use of the aforesaid heater is that the maximum temperature to which the box with its delicate components is heated can be made not to exceed a safe temperature of the internal components and in addition unlike prior hot plate or oven approaches the entire box is not heated, only the edges contacting the lid.

In consequence of the above invention, the lids for hermetically sealed boxes may be applied in such a manner that the delicate internal circuit(s) is not and in fact cannot be damaged and importantly the lid may be removed and reapplied at anytime, again without fear of damaging delicate circuit components.

Arrangements according to the invention will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 is a top view of a first embodiment of the present invention;

Figure 2 is a side view of the embodiment of Figure 1;

Figure 3 is a sectional view of the lid of Figures 1 and 2 applied to a box;

Figure 4 is a top view of a preferred embodiment of the present invention;

Figure 5 is a side view of one realization of the embodiment of Figure 4;

Figure 6 is a graph plotting resistance of a U-shaped energizing circuit i.e. conductor, as a function of conductor width and separation of the legs of the U.

Figure 7 is a graph plotting inductance of a U-shape energizing circuit i.e. conductor, as a function of conductor width and separation of the legs of the U.

Referring now specifically to Figures 1 and 2 of the accompanying drawings, there is illustrated one embodiment of a lid and heater 1 according to the present invention. A lid 2 has secured thereto a magnetic material 3. The securing substance, which is designated by reference numeral 5, may permanently or temporarily bond the material 3 to the lid. If the bonding is to be permanent a high temperature solder or brazing substance may be used, it being required that the fusion temperature of the magnetic material be well above the fusion temperature of the substance attaching the lid to the box.

To complete the structure, an insulating tape 7 having a U-shaped conductor 9, preferably of copper, attached to one surface, is adhered to the magnetic material by a tacky substance 11 on the surface opposite the U-shaped conductor 9.

In the present embodiment, the material of the lid serves as the electrical conductor into which current spreads when Curie temperature is approached and thus a separate conductive layer is not required. This embodiment is particularly applicable when the lid is copper or a material having a quite low resistivity whereby a quite high auto-regulating ratio is available.

Referring now specifically to Figure 3 of the accompanying drawings, there is illustrated, the lid 2 applied to a box 15 prior to sealing of the lid to box 15. Walls 17 and 19 of the lid 2 have, in their upper edges as viewed in Figure 3 a groove 21 to receive solder 25 or the like. As previously indicated, the solder may be pre-applied and bonded to the walls or may be a solder preform, solder paste or wire laid in the grooves. In either event, the solder must extend above the walls to ensure good contact with the lid. Upon heating of the lid, the solder melts, transfers sufficient heat to the upper regions of the walls 17 and 19 to insure wetting of the walls by the solder and upon termination of heating results in excellent bond between the members.

It should be noted that if the solder is to be applied to the walls prior to application of the lid, the groove 21 may be eliminated; however, some trouble may be encountered in subsequent removals and reapplications of the lids when some solder has been removed and the grooves are not available to receive solder wire or paste.

Referring now specifically to Figure 4 of the accompanying drawings, there is illustrated a second embodiment of the present invention. In this embodiment of the invention energizing conductor 29 follows closely the outer periphery of a lid 31 and has extensions 33 and 35 of each end of the conductor 29 extending well beyond the lid 31. These extensions serve two purposes; they permit ready connection of a power supply to the conductor 29 and they provide a tab, together with an overlying insulation layer 37, to pull the conductor off the lid.

Figure 5 illustrates in elevation one realization of the heater of Figure 4. A layer 39 of highly conductive material, such as copper, is secured, permanently or otherwise, to lid 31 by a bonding agent 41. The copper layer is covered with a thin layer 43 of magnetic material having a prescribed Curie temperature. The magnetic material is covered with insulating layer 45 which may be permanently or temporarily (usually temporarily when the tabs 33 and 35 are provided) bonded to the magnetic layer 43.

The devices of Figures 4 and 5 together have the advantage over that of Figures 1 and 2 in that the heat is concentrated in the region under which the solder is located thus increasing the speed at which the operation may be performed and further decreasing the heat conducted to delicate electronic components.

In preliminary tests performed on the structure of Figure 1, in one case, and in the other with such structure modified as in Figure 5 to include a copper layer between the magnetic material and the lid, two lids were tested with different magnetic materials. The unmodified lid of Figure 1 employed Metglas Alloy 2714A having a Curie temperature of 220°C (METGLAS is a Registered Trade Mark). The other or modified lid employed was TC32 alloy clad on copper. It has a Curie temperature of 150°C. The heaters were secured to lids made of aluminum plated with tin. The lids weighed 2.38 grams and were 0.032 inch (0.081 cm) thick and tinned all over. The box to which the lids were to be attached weighed 33.5 grams. The heaters were operated at 50, 80 and 100 watts and the Metglas heater was also and in addition operated at 30 and 150 watts.

The heaters performed properly, but the Curie temperature of TC32 alloy was too low and soldering could not be effected. On the other hand, the Metglas lid effected soldering but the lid became somewhat hotter than desired for this particular solder. TC32 has the desired temperature. Thermal contact between the lid and box was found to be quite good even in the absence of solder. However, the boxes heat up slowly so that 100-150 watts is the proper range of operation of the heater; such input power heating the system to the requisite temperature in approximately 20 seconds. The required time is reduced by the structure of Figure 4 as the heat energy input is concentrated directly over the box which as indicated above heats relatively slowly.

The dimensions of the heater both planar and in depths are defined in US-A-4,256,945, but are briefly reiterated for purposes of conciseness. Themagnetic material should be roughly 0.5 to 1.8 times skin depth at the frequency of operation. Skin depth in centimeters is defined by the equation

$$S.D. = 5030 \sqrt{\frac{\rho}{f\mu_r}}$$

where p is the resistivity in ohm-cm of the magnetic material, μ_r is the permeability of the magnetic material and f is the frequency of the source in Hz. In a typical case using Alloy 42, μ_r200 , p is 75×10^{-6} ohm-cm and *f* is 13.56 MHz. Thus skin depth is approximately .0008365 cm and the magnetic layer should be approximately .0008365 cm thick. The underlying layer should be about 5 skin depths at a μ_r of 1 and a p = $2x10^{-6}$ ohm cm to provide low resistance current carrying capacity above Curie temperature and to insure adequate shielding of the magnetic field to the outside world. In this context see WO 82/03305. Thus, the underlying layer should be 0.009659 cm.

Additional consideration must be given to the heater structure and in particular to the width to thickness ratio of the magnetic layer. If the magnetic layer is completely surrounded by a conductive layer then the intrinsic permeability of the magnetic material may be realized. If, however, the magnetic layer has exposed edges as in the present application then the intrinsic permeability cannot be realised. The equation for the relationship between intrinsic and effective permeability for a rectangle is extremely complex but can be approximated by the following equation for an ovoid.

$$\mu_E = \mu_I \cdot \frac{1}{1 + \mu_I \left(\frac{t}{w + t}\right)}$$

where μ_E is effective permeability, μ_I is intrinsic permeability, t is thickness and w is width. The table below illustrates the effect of both permeability and the w/t ratio on the effective permeability.

μ_I	200	400
w/t		
10	10	10
25	23	24
50	41	44
100	67	80
200	100	133
300	120	171
400	133	200
500	143	227
1000	167	286

Thus it is seen that the greater the ratio the higher the effective permeability and the lower the intrinsic permeability the higher the ratio of μ_E/μ_I. For instance, the ratio μ_E/μ_I for w/t equal to 1000 is 0.835 for a permeability of 200 but is only 0.715 for a permeability of 400.

There are certain dimensions that must be observed relative to location of the legs of the energizing conductor such as conductor 9 of Figure 1.

Referring specifically to the graph of Figure 6, the graph depicts resistance as a function of bus separation, i.e. the separation between legs of the U-shaped construction of Figure 1 for various widths of the conductor for a bus length of 8 inches (20 cm). It is seen that above approximately 0.1 inch (0.25 cm) separation or more, the bus resistance remains essentially constant regardless of conductor width "w". It will be noted that with a conductor width of 0.05" (0.127 cm), resistance drops materially below separations of 0.2 (0.51 cm) or less. Thus, if conductor widths of 0.1 (0.25 cm) or greater and conductor separation of approximately 0.1 (0.25 cm) or more or conductor spacings of 0.25 inch (0.63 cm) or more are maintained, relatively high resistances are achieved. Spacing and widths of 0.1 (0.25 cm) are preferred in most instances providing quite high resistance, i.e., 6 to 6.5 ohms.

The effects of conductor width and separation on the reactive components of impedance are illustrated by the graphs of Figure 7. much the same characteristics are present as in the resistive case. A conductor width of 0.05 (0.127 cm) produces a downward sloping curve, a width of 0.1" (0.25 cm) produces an essentially flat curve down to separations of about 1.5 inch (3.8 cm) with bus lengths of 8 inches (20 cm). The above dimensions of width and depth are for a 13.56 MHz system having energizing circuit thickness of approximately 0.003 inch (0.0076 cm). The circuits on which these tests were conducted are adapted to deliver 100-150 watts of power under full load.

The term "constant current" as employed herein does not mean a current that cannot increase, but means a current that obeys the following formula:

$$\frac{\Delta|I|}{|I|} < -\ 1/2\ \frac{\Delta R}{R}$$ where I is the load current,

Specifically, in order to autoregulate, the power delivered to the load when the heater exceeds Curie temperature, must be less than the power delivered to the load below Curie temperature. If the current is held invariable, then the best autoregulating ratio is achieved short of controlling the power supply to reduce current. So long, however, that the current is controlled in accordance with the above formula, auto-regulation is achieved. Thus, when large autoregulating ratios are not required, constraints on the degree of current control may be relaxed thus reducing the cost of the power supply. The above equation is derived by analyzing the equation:

$$P = |I|^2 R$$

where P is power and I is the current in the load.
Differentiating with respect to R

$$\frac{dP}{dR} = |I|^2 + 2R|I|\frac{dI}{dR}$$

to satisfy the requirements for autoregulation

$$\frac{dP}{dR} < \emptyset.$$

Thus,

$$|I|^2 + 2R|I|\left(\frac{d|I|}{dR}\right) < \emptyset,$$

which reduces to the above equation. It should be noted, however, that the more constant the current the better the autoregulation.

Claims

1. An assembly comprising a first member, such as a cover, sealable to a second member, such as a box, by heat-activated sealant, and a temperature-regulated electrical heater positioned to provide Joule heating to activate the sealant and having an energising circuit adapted to be connected to a source of alternating current, characterised in that the temperature-regulated heater is an auto-regulating heater comprising a layer (3,43) of a magnetic material that undergoes a substantial change in electrical impedance with change in temperature and is secured on one surface of said first member (2,31), said energising circuit (9,29) is adhered to said auto-regulating heater magnetic layer, and said auto-regulating heater further has an electrically-conductive layer (2,39) provided either by said first member (2) or by an additional electrically-conductive layer (39).

2. An assembly according to claim 1, wherein said first member is a cover to be hermetically sealed to a box constituting said second member and said auto-regulating heater magnetic layer is on the outer surface of the cover.

3. The assembly according to claim 2, wherein said cover is adapted to mate with said box over a defined area of the surface of said cover opposite to that on which the auto-regulating heater layer or layers are

disposed, said heat-activated sealant being disposed between said cover and said box at said mating area.

4. The assembly according to claim 2 or claim 3, wherein said heater magnetic layer is permanently bonded to said cover.

5. The assembly according to any preceding claim, wherein said energising circuit is inductively coupled to said auto-regulating heater.

6. The assembly according to any preceding claim, in which said energising circuit is removably adhered to said auto-regulating heater magnetic layer.

7. The assembly according to claim 3, or any of claims 4 to 6 taken with claim 3, wherein the magnetic layer of the auto-regulating heater is chosen to have a Curie temperature high enough to activate the sealant but not high enough to damage the box or its contents.

8. The assembly according to claim 7, wherein a highly electrically conductive layer (39), such as copper, is bonded to the outer surface of the cover between the cover and the magnetic layer of the heater.

9. The assembly according to any of claims 2, 3, 7 and 8, wherein said cover and said box are of metal.

10. The assembly according to any preceding claim, wherein the heat activated sealant is contained in a channel in the first or second member.

11. A method of sealing a cover to a box such that the cover and box can be subsequently unsealed, and wherein the sealing is achieved by means of a heat-activated sealant that is activated by a temperature-regulated electrical heater energised by a source of alternating current, comprising the steps of:
i) affixing to the outer surface of the cover a layer of a magnetic material that undergoes a substantial change in electrical impedance with change in temperature, said magnetic layer having contiguous with it an electrically-conductive layer provided either by the cover itself or an additional layer, the two layers constituting an auto-regulating electrical heater,
ii) applying a heat-activated sealant between the mating surfaces of the cover and box,
iii) adhering an energising electrical circuit to said magnetic layer,
iv) and passing alternating current through said energising circuit such as to raise the temperature of the auto-regulating heater to a level at which the sealant is activated but which cannot substantially exceed the temperature level at which the heater auto-regulates.

Revendications

1. Ensemble comprenant un premier organe tel qu'un couvercle pouvant être fixé de façon étanche à un second organe tel qu'une boîte au moyen d'un matériau d'étanchéité activé par la chaleur, et un dispositif électrique chauffant à température régulée positionné de façon à appliquer un chauffage Joule qui active le matériau d'étanchéité et qui comprend un circuit d'excitation adapté à être relié à une source de courant alternatif, caractérisé en ce que le dispositif chauffant à température régulée est un dispositif chauffant auto-régulé comprenant une couche (3, 43) d'un matériau magnétique qui subit une modification substantielle d'impédance électrique quand la température varie et qui est fixé sur une surface dudit premier organe (2, 31), ledit circuit d'excitation (9, 29) est collé à ladite couche magnétique chauffante auto-régulée et ledit dispositif chauffant auto-régulé comprenant en outre une couche électriquement conductrice (2, 39) fournie soit par le premier organe (2) soit par une couche électriquement conductrice additionnelle (39).

2. Ensemble selon la revendication 1, dans lequel ledit premier organe est un couvercle qui doit être fixé de façon hermétique sur une boîte constituant ledit second organe et ladite couche magnétique du dispositif chauffant auto-régulé est prévue sur la surface extérieure du couvercle.

3. Ensemble selon la revendication 2, dans lequel ledit couvercle est adapté à coopérer avec ladite boîte sur une région définie de la surface dudit couvercle qui est opposée à celle sur laquelle la ou les

couches du dispositif chauffant auto-régulé sont disposées, ledit matériau d'étanchéité activé par la chaleur étant disposé entre ledit couvercle et ladite boîte dans ladite région de coopération.

4. Ensemble selon la revendication 2 ou la revendication 3, dans lequel ladite couche magnétique du dispositif chauffant est liée de façon permanente audit couvercle.

5. Ensemble selon l'une quelconque des revendications précédentes, dans lequel ledit circuit d'excitation est couplé de façon inductive audit dispositif chauffant auto-régulé

6. Ensemble selon l'une quelconque des revendications précédentes, dans lequel ledit circuit d'excitation est lié de façon amovible à ladite couche magnétique du dispositif chauffant auto-régulé.

7. Ensemble selon la revendication 3 ou l'une quelconque des revendications 4 à 6 prises avec la revendication 3, dans lequel la couche magnétique du dispositif chauffant auto-régulé est choisie de manière à présenter une température de Curie suffisamment élevée pour activer le matériau d'étanchéité mais insuffisamment élevée pour endommager la boîte ou son contenu.

8. Ensemble selon la revendication 7, dans lequel une couche fortement électriquement conductrice (39) telle que du cuivre est liée à la surface extérieure du couvercle entre le couvercle et la couche magnétique du dispositif chauffant.

9. Ensemble selon l'une quelconque des revendications 2, 3, 7 et 8, dans lequel ledit couvercle et ladite boîte sont en métal.

10. Ensemble selon l'une quelconque des revendications précédentes, dans lequel le matériau d'étanchéité activé par la chaleur est contenu dans une canalisation du premier ou du second organe.

11. Procédé de fermeture étanche d'un couvercle sur une boîte tel que le couvercle et la boîte peuvent être à nouveau ouverts par la suite, dans lequel la fermeture étanche est obtenue au moyen d'un matériau d'étanchéité activé par la chaleur, qui est activé par un dispositif électrique chauffant à température régulée et excité par une source de courant alternatif, comprenant les étapes consistant à:
i) fixer sur la surface externe du couvercle une couche d'un matériau magnétique qui subit une modification substantielle d'impédance électrique quand la température change, ladite couche magnétique étant contiguë d'une couche électriquement conductrice fournie soit par le couvercle lui-même soit par une couche additionnelle, les deux couches constituant un dispositif électrique chauffant auto-régulé,
ii) appliquer un matériau d'étanchéité activé par la chaleur entre les surfaces coopérantes du couvercle et de la boîte,
iii) faire adhérer un circuit électrique d'excitation à ladite couche magnétique,
iv) et faire passer un courant alternatif par ledit circuit d'excitation de manière à élever la température du dispositif chauffant auto-régulé à un niveau auquel le matériau d'étanchéité est activé mais qui ne peut pas sensiblement dépasser le niveau de température auquel s'auto-régule le dispositif chauffant.

Ansprüche

1. Anordnung mit einem ersten Teil, beispielsweise einem Deckel, das dichtend mit einem zweiten Teil, beispielsweise einem Kasten, durch wärmeaktiviertes Dichtungsmittel verbindbar ist, und mit einem temperaturregulierten elektrischen Heizer, der so angeordnet ist, daß er Joule'sche Wärme liefert und das Dichtungsmittel aktiviert,und einen Speisekreis aufweist, der mit einer Wechselstromquelle verbindbar ist, **dadurch gekennzeichnet**, daß der temperaturregulierte Heizer ein selbstregulierender Heizer ist, der aufweist eine Schicht (3, 43) eines magnetischen Materials, das einer wesentlichen Änderung seiner elektrischen Impedanz bei Änderung der Temperatur unterliegt und auf einer Oberfläche des ersten Teils (2, 31) befestigt ist, das der speisende Kreis (9, 29) an der genannten selbstregulierenden magnetischen Heizschicht anhaftet, und daß der selbstregulierende Heizer darüber hinaus eine elektrisch leitende Schicht (2, 39) aufweist, die entweder durch das genannte erste Teil (2) oder durch eine zusätzliche, elektrisch leitende Schicht (39) gebildet ist.

2. Anordnung nach Anspruch 1, **dadurch gekennzeichnet**, daß das genannte erste Teil ein Deckel ist, der hermetisch gegenüber einem Kasten abgedichtet werden soll, der das zweite Teil bildet, und daß die selbstregulierende magnetische Heizschicht sich auf der äußeren Fläche des Deckels befindet.

3. Anordnung nach Anspruch 2, **dadurch gekennzeichnet**, daß der genannte Deckel mit dem genannten Kasten über einen definierten Bereich der Oberfläche des Deckels in Eingriff bringbar ist, der dem gegenüberliegt, auf dem sich die selbstregulierende Heizschicht oder -schichten befinden, wobei das wärmeaktivierte Dichtmittel zwischen dem genannten Deckel und dem genannten Kasten an dem genannten Eingriffsbereich angeordnet ist.

4. Anordnung nach Anspruch 2 oder 3, **dadurch gekennzeichnet**, daß die magnetische Heizschicht permanent mit dem Deckel verbunden ist.

5. Anordnung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß der Speisekreis induktiv mit dem genannten selbstregulierenden Heizer gekoppelt ist.

6. Anordnung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß der genannte Speisekreis lösbar an der selbstregulierenden magnetischen Heizschicht anhaftet.

7. Anordnung nach Anspruch 3 oder einem der Ansprüche 4 bis 6 in Verbindung mit Anspruch 3, wobei die magnetische Schicht des selbstregulierenden Heizers so gewählt ist, daß sie eine Curie-Temperatur hat, die hoch genug ist, um das Dichtmittel zu aktivieren, jedoch nicht hoch genug, um den Kasten oder seinen Inhalt zu zerstören.

8. Anordnung nach Anspruch 7, **dadurch gekennzeichnet**, daß eine elektrisch hochleitende Schicht (39), wie beispielsweise Kupfer, an die äußere Oberfläche des Deckels zwischen dem Deckel und der magnetischen Schicht des Heizers angeklebt ist.

9. Anordnung nach einem der Ansprüche 2, 3, 7 und 8, **dadurch gekennzeichnet**, daß der genannte Deckel und der genannte Kasten aus Metall bestehen.

10. Anordnung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß das wärmeaktivierte Dichtmittel in einem Kanal in dem ersten oder zweiten Teil gehalten ist.

11. Verfahren zum Abdichten eines Deckels mit einem Kasten, derart, daß der Deckel und Kasten nachfolgend wieder gelöst werden können, und wobei das Abdichten mittels eines wärmeaktivierten Dichtmittels erfolgt, das durch einen temperaturregulierten elektrischen Heizer aktiviert wird, der durch eine Wechselstromquelle gespeist ist, aufweisend die Schritte:
i) An die äußere Oberfläche des Deckels wird eine Schicht von magnetischem Material befestigt, das einer wesentlichen Änderung der elektrischen Impedanz bei Änderung in der Temperatur unterliegt, wobei die magnetische Schicht an eine elektrisch leitende Schicht angrenzt, die entweder durch den Deckel selbst oder durch eine zusätzliche Schicht gebildet ist, wobei die beiden Schichten einen selbstregulierenden elektrischen Heizer bilden,
ii) Zuführen eines wärmeaktivierten Dichtmittels zwischen die aneinandergreifenden Flächen des Deckels und des Kastens,
iii) Anschließen eines speisenden elektrischen Kreises an die magnetische Schicht,
iv) und Durchschicken eines Wechselstromes durch den Speisekreis, um so die Temperatur des selbstregulierenden Heizers auf ein Niveau anzuheben, bei dem das Dichtmittel aktiviert ist, das jedoch nicht wesentlich den Temperaturpegel übersteigen kann, bei dem sich der Heizer selbstreguliert.

Fig.1

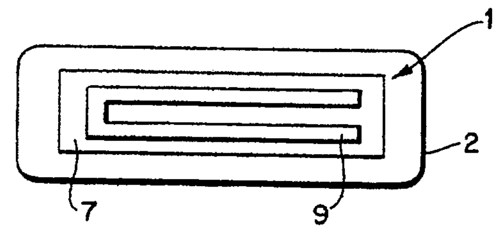


Fig.2

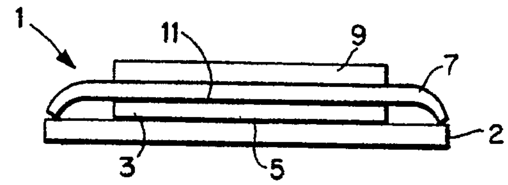


Fig.3

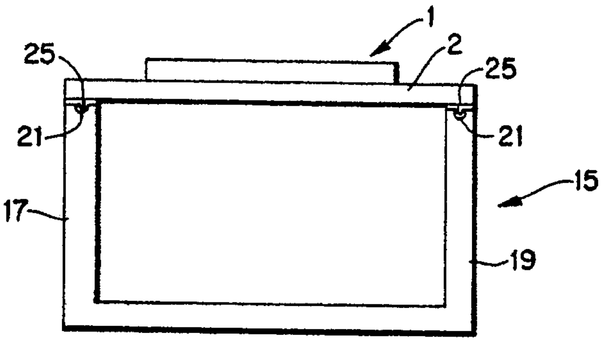


Fig.4

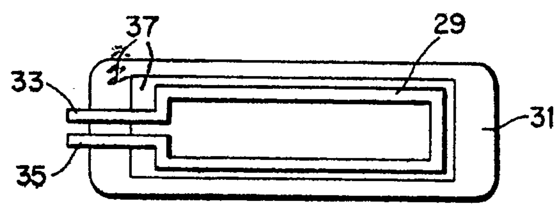


Fig.5

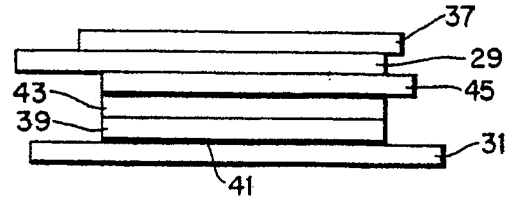


Fig.6

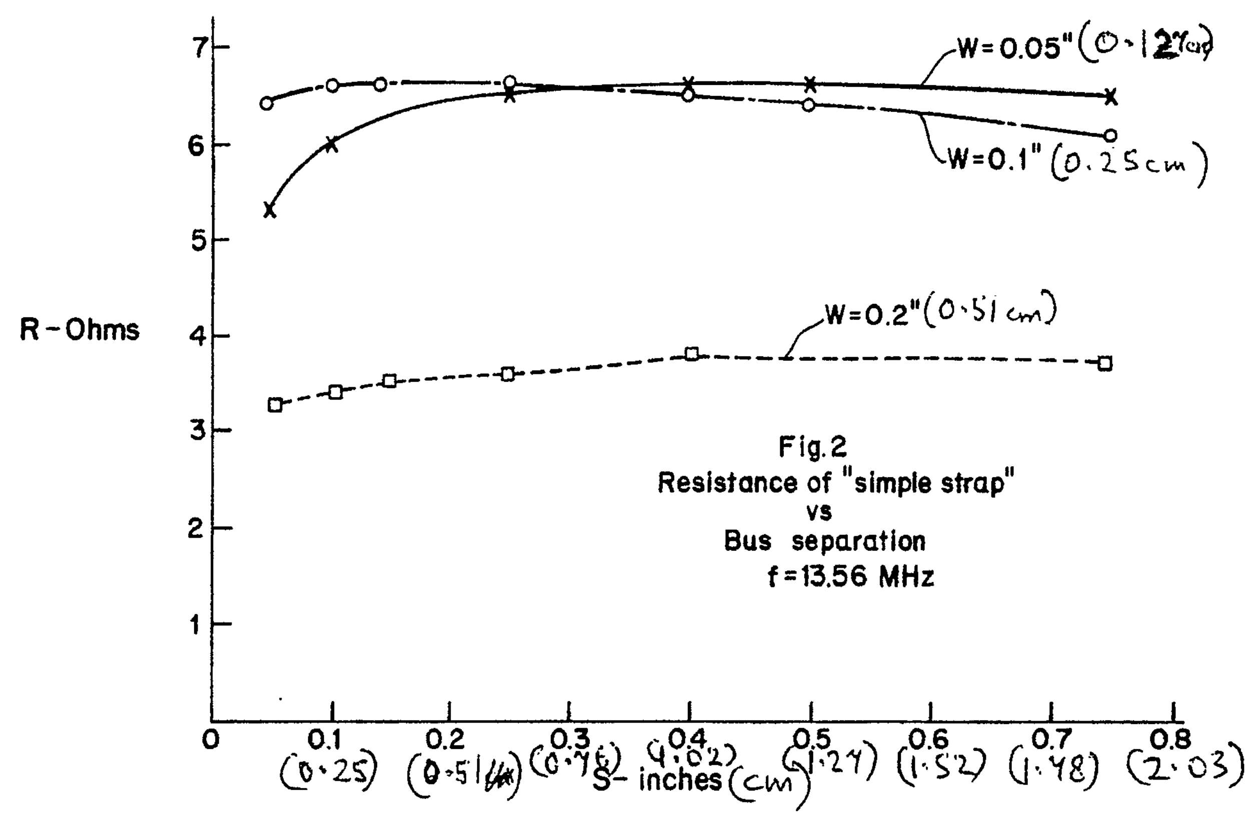
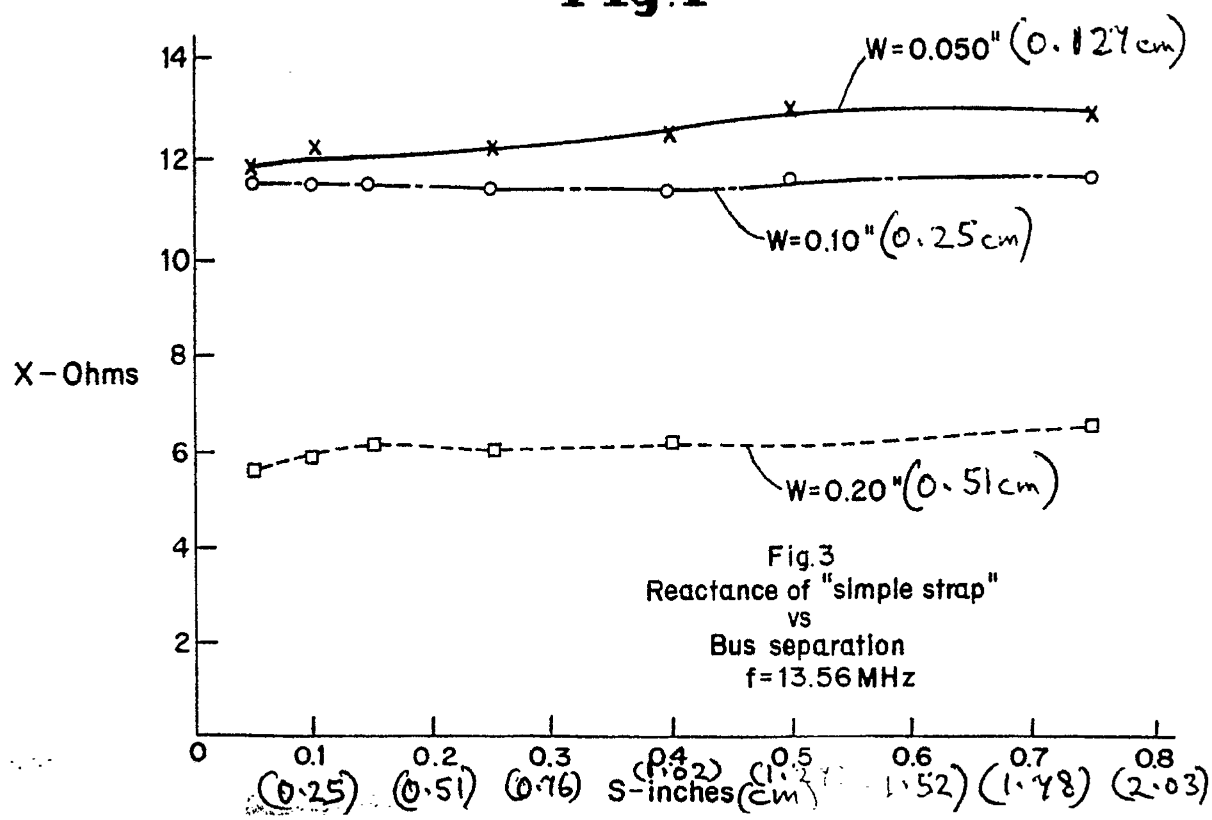

W=0.05" (0.127cm)
W=0.1" (0.25cm)
W=0.2" (0.51cm)
R-Ohms
Fig.2
Resistance of "simple strap"
vs
Bus separation
f=13.56 MHz
S- inches (cm)

Fig.7


W=0.050" (0.127cm)
W=0.10" (0.25cm)
W=0.20" (0.51cm)
X-Ohms
Fig.3
Reactance of "simple strap"
vs
Bus separation
f=13.56 MHz
S-inches (cm)